د/ أكرم

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$\sigma_u = 3.5\ HB$ → رمز للصلادة (برنل)

الصلادة ← مقاومة المادة للخدش أو للعلامة

* إذا قسنا الصلادة مضروبة في (3,5) نحصل على ultimate stress

الإجهاد المسموح في حالة الـ Bending ← $(\sigma_{en})_{bending} = 0.5\ \sigma_u$

$$(\sigma_{en})_{bending} = 1.75\ HB$$

$$\tau = 0.6\ \sigma_{en}$$

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* Pure Torsion

$$T = \frac{1000 * 60 P_{\to (kw)}}{2 \pi N_{\to (r.p.m)}}$$

Shaft diameter (Solid)

$$D = \sqrt[3]{\frac{16 T}{\pi \tau}} \quad \tau \to \text{shear allowable}$$

Shaft Hollow

$$D_o = \sqrt[3]{\frac{16 T}{\pi \tau} * \frac{1}{1-K^4}}$$

τ → shear design

$$K = \frac{D_i}{D_o}$$

θ angle of Torsion

$$\theta = \frac{T L}{J G} \to (\text{Solid})$$ في حالة الـ

$$= \frac{584 T L}{G d_o^4 (1-K^4)}, \text{degree} \to (\text{Hollow})$$ في حالة الـ

Scanned by CamScanner

For high accuracy of machining $\leq 0.1\,L$ degree

Camshaft of an engine is 0.5 degrees irrespective of length (مع عدم الاهتمام بالطول)

for other shaft $\theta = 1^\circ$ in, 20D length

** Strength in simple bending

$$\sigma = \frac{32\,M}{\pi D^3}$$

*** Combined bending & Torsion

$$\sigma = \frac{32M}{\pi D^3} \quad \& \quad \tau = \frac{16T}{\pi D^3}$$

$$\tau_{max} = \sqrt{\left(\frac{\sigma}{2}\right)^2 + \tau^2}$$

$$\tau_{max} = \left[\sqrt{M^2 + T^2}\right]\left[\left(\frac{16}{\pi D^3}\right)\right]$$

$$D = \left[\frac{16}{\pi \tau} T_{eq}\right]^{1/3}$$

Shear allowable

Page 337 $\boxed{\text{ASME}}$. * Max shear ~~diameter~~ ductile material

$$d_o^3 = \left[\frac{16}{\pi \tau (1-K^4)}\right] * \sqrt{\left[C_m M + \frac{\alpha F_a d_o (1+K^2)}{8}\right]^2 + (C_t T)^2}$$

$$\tau = \frac{\tau_y}{n}$$

F * <u>Brittle material</u>

$$d_o^3 = \frac{16}{\pi \sigma (1-K^4)} \left\{ C_m M + \frac{\alpha F_a d_o (1+K^2)}{8} + \sqrt{\left[C_m M + \frac{\alpha F_a d_o (1+K^2)}{8}\right]^2 + (C_t T)^2} \right\}$$

$\boxed{\text{Table } 12{,}2}$

accounting ASME Code

$\tau = 0{,}3\,\sigma_y$ or $\tau = 0{,}18\,\sigma_u$

A Code recommends stress reduce 25%
if stress concentration due to Keyway
خابور

* <u>dynamic load</u>

$$d = \left[\frac{32}{\pi(\sigma_y/n)} \left[\left(M \frac{\sigma_y}{\sigma_{en}}\right)^2 + \frac{3}{4} T^2\right]^{1/2}\right]^{1/3}$$

* <u>static Load</u>

$$d = \left[\frac{32}{\pi(\sigma_y/n)} \left[M^2 + \frac{3}{4} T^2\right]^{1/2}\right]^{1/3}$$

" <u>Keys</u> " Page 340

<u>stresses in Keys</u>

$F_s = w\,l\,\tau$

$T = F_s * \frac{d}{2}$

$F_c = \frac{t}{2} * l * \sigma$ ⇒ (Curshing strength)

table 12,3

Splines

$$T = \frac{1}{2} p h L i D_m$$

$$D_m = \frac{D+d}{2}$$

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Ex : 12,6

select Key way = ?

$d_{shaft} = 100\ mm$

$\sigma_{crushing} = 200\ MPa$

$\tau_{all} = 30\ MPa$

$\sigma_c = 120\ MPa$

* $T = \dfrac{P}{\omega} = \dfrac{750 * 1000 * 60}{2\pi * 1000} = 7162\ N.m$

  $\omega \rightarrow 2\pi n$

* $F_s = \dfrac{T}{r} = \dfrac{7162 * 1000}{100} = 1,43 * 10^5\ N$

* $F_s = w L \tau$

  $L = \dfrac{F_s}{w \tau} = \dfrac{1,43 * 10^5}{25 * 100} = 57,2\ mm$

  $\omega \rightarrow \dfrac{2\pi n}{60}$

table page 342